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ABSTRACT

This exploration of possible information and communications developments in the future focuses on the picture of the family or individual depending on access to information as a key to their status in society. The scenario involves the home as the center for conducting business, banking, shopping, and receiving lifelong education, and this paper explores the questions of whether this is an accurate picture, how it is to be accomplished, and what sort of timetable it will entail. Distribution, storage, and control technologies are discussed, including broadcast transmissions; Multipoint Distribution Services (MDS) and Instructional Television Fixed Services (ITFS); direct broadcast satellites; cable television; fiber optics; radio and television subcarriers; teletext and videotex; home computers; videodiscs; video cassettes; high definition television; and "smart cards," i.e., small computer chips imbedded between the plastic layers of bank and credit cards. A brief look at implications of the information and communications revolution for society concludes the paper. (THC)

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THE TECHNOLOGICAL REVOLUTION IN THE HOME

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National Institute of Education's
Conference on Computers in the Home---New
Opportunities and Challenges for Education

There is a quiet revolution taking place in this country, and its presence can be felt in homes all over the land. We are a nation noted for our rapid changes and developments in technology. However, the pace of that development in the home environment is moving faster than anyone had believed possible. Only thirty years ago, not a very long time as history goes, information was one thing and communications another. That was when television was Milton Berle and telephones were Bell. That was before satellites, video cassettes and home computers. Those times no longer exist. The merging of the communications and the information industries have changed everything. The traditional boundaries no longer exist and the home has become a place which has access to the world around it.

In Daniel Bell's book The Coming of the Post Industrial Society, we were told of the changes taking place in the movement from a post-industrial period to a technological-electronic era, as the nation's economy moved from one which was product or hardware oriented to one which is service oriented. In such a society, power gravitates to

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those who control modern technology.

In 1980, seven years after Bell's book, Toffler's The Third Wave reiterated this theme from a slightly different perspective. Toffler predicted the rise of the information society and the coming into the home of individualized entertainment, information and education through modern electronic technology.

The scenario painted by these and others are strikingly similiar, almost as though a concensus had already been reached by many of today's visionaries. This picture has the individual or family depending on access to information as a key to its status in society. It is a scenario where the home becomes the center for conducting business, banking, shopping and receiving lifelong education. If this is an accurate picture, how is it to be accomplished and what sort of timetable can we expect? These are the questions we will explore this morning.

Before I begin, I would like to caution you that I am not trying to predict the future. What I am trying to do is to point out some of the possibilities which I see just ahead of us. But even this is difficult. Even when a technology exists, it is often not possible to imagine how it will affect you. As an example of this, let me describe an incident related to me by Arthur C. Clarke which occured about 100 years ago in England. A parliamentary commission was called

to deal with the very startling news from the United States that a certain Mr. Thomas Edison had invented an electric light. The gas companies were alarmed that such an invention could injure their business. Experts called before the Commission, however, assured the companies that nothing further would be heard of this ridiculous invention. One of the expert witnesses called was the Chief Engineer of the British Post Office. He was asked in passing about the other American invention, the telephone. His response was that England did not have a need for a telephone since it had plenty of messenger boys!

All of these experts completely failed to see the telephone and the electric light for the revolutionary inventions we know them to be. Who could imagine a home without either today? Had I asked you in the 1940's the same question about television, what would your response had been?

Distribution

Let's begin with a few basics. There are two technologies to understanding in the home environment. The first is distribution, and the second is storage and control. A wide variety of means are available to bring information, entertainment and education into the home. These include broadcasting, cable TV, direct broadcast satellites, radio subcarriers, telephone wires and fiber optics-to name the most prominent. In the home we have the ubiquitous television set;

a variety of storage mediums including video discs, video cassettes, floppy disks and solid state cartridges; home computers with their own storage capabilities and modems; and a panoply of special equipment including digital audio discs, videotext terminals, teletext decoders, SCA receivers and special purpose computers.

Distribution refers to how the information gets to the home. Once in the home environment it must be displayed, stored and manipulated for the user's convenience. Some of the information which reaches the home is general and intended for the mass audience, while some of this distributed material is highly individualized, i.e., directed specifically at one person or a family.

In order for the information to be distributed, it must first be transformed into electronic signals or pulses. This process is called modulation and can be either analog or digital. The next step involves transmission either over the air or through an enclosed medium. Signals transmitted through the air can be broadcast by terrestrially-based transmitters; broadcast from satellites in space; or be sent by microwave from one point to many. Signals which are distributed through enclosed mediums can use coaxial cable, twisted pair copper wire, or fiber optic cables all of which must necessarily be installed on a home-by-home basis.

Broadcasting

We are already familiar with broadcast transmissions such as television and radio, and I will not dwell on these technologies. I would mention, however, that the Federal Communications Commission recently opened up thousands of new channels in both television and radio. In television, these new frequencies go under the generic name of Low Power TV (LPTV). These use small transmitters of 10 to 100 watts capable of serving an area of perhaps ten to fifteen miles, depending on the height of the tower used and the terrain surrounding the transmitter. In large metropolitan areas, coverage could be as small as two to five miles. There are some ten thousand applications for these Low Power TV licenses pending at the FCC at this time, and no more are being accepted until the backlog clears up. In radio, the FCC recently opened up approximately 700 new FM channels across the country and promises to make available several thousand frequencies in the near future. Like TV, these radio channels have less reach than standard stations but will cover most medium sized cities. All of these channels, radio and TV, are available to non-commercial and commercial applicants alike, with special preferences being awarded by the FCC to not-for-profit and minority applicants.

MDS & ITFS

Information, entertainment and education can also reach

the home by microwave. These services go under the name of MDS or ITFS. Both use the same technology and the same frequency bands. MDS, or Multipoint Distribution Services, and ITFS, Instructional Television Fixed Services, operate by transmitting microwave signals directly to specific locations within their immediate area of 20-25 miles. The locations served must be capable of being physically viewed, or what we call line-of-sight. Unlike broadcast signals which can propagate through the ether, microwave signals do not bend around corners or buildings or go through walls or trees. Each receiving site must be seen by the transmitter.

According to new FCC rules, both MDS and ITFS operators can use their channels to send Pay-TV to the home if they wish. In addition, ITFS operators can lease their channels to commercial interests in off hours and derive revenue from this arrangement. Some commercial operators are amassing up to eight MDS channels in certain cities and offering services which they hope can compete with cable TV systems. While cable TV is a capital intensive business often costing tens of millions of dollars to wire a city, an MDS operator can install a competing system for as little as one or two million dollars and thereby charge much lower fees for his service. At first glance, having only eight channels might appear to be a significant disadvantage in marketing the service. However, experts in the field are inclined to

believe that consumers never watch more than six or seven channels in any case. Thus the additional capacity on cable often goes unused and costs the cable operator money; - first in building the multi-channel system and secondly in providing the extra programs. Schools can use this microwave technology to transmit programs directly to the home, especially if the channels are leased in off-hours to commercial operators who install home receivers for their service. Past use of ITFS has always concentrated on sharing programs between schools, rather than between schools and the home. This can dramatically change with the introduction of low cost home receiving hardware. Multiple channel television capability from the schools to their communities opens up many opportunities for serving homebound students, extension services, school bulletins and announcements, registration procedures and lifelong education possibilities.

Direct Broadcast Satellites

Another, more exotic, means for delivering information to the home is by Direct Broadcast Satellite. Presently one company, United Satellite Communications Inc., USCI, is offering home satellite television, 24-hours a day, 365 days a year. Five channels of television programming are offered including a sports network, top Hollywood movies, a full-time news network and video music. This satellite service is an appealing alternative to cable TV and other delivery options

especially in rural areas. By using a small satellite dish, which can be leased or purchased, the home is in direct contact with the satellite and can tune to any of its programs. Equipment is being sold and serviced by Radio Shack and can be purchased today for \$395 installed. A full years subscription costs \$300 (\$25/month). The USCI is called low-power DBS since the satellite used is not as powerful as those authorized by the FCC for DBS operations. Rather USCI has jumped into the business to beat the higher powered services to the marketplace, thus hoping to capture a significant number of homes to which such a service is attractive. Another company which has talked about its DBS service for a number of years is the Satellite Television Corporation, STC, a subsidiary of COMSAT. STC is planning to compete with USCI in the near future by also going to a low power DBS while its more advanced high power satellites are being built. The principal difference between low power and high power DBS systems is in the size and cost of the home receiving stations. STC predicts its home earth station will cost less than USCI's using a high powered DBS. Others have predicted costs less than half that amount when mass production quantities are achieved. Nine other companies have asked the FCC for authority to launch and operate DBS systems in the United States, and the FCC is expected to approve many of these applications. Most should be in operation before 1990 if the service proves to be attractive to consumers. The

question being posed at this time is whether enough programming can be generated to fill all of this capacity. If every system has the same programs as most pay cable channels do, very few systems could be supported and would survive.

DBS opens the door to a university of the air service where such capacity could obviously be utilized if available. When the shakeout comes and those systems in orbit which have not survived the commercial competition go dark, their capacity might well be available to educators whose thirst for avenues to the home could easily fill the programming void.

Another means for bringing information into the home is by wire or cable. This could be cable TV, telephone wire or fiber optics. Each of these systems has different capabilities and advantages. Clearly the nation is already wired in a fully switched and interconnected system with twisted copper wire delivering telephone service to almost every home. Each home can talk to every other home no matter where it is. But the twisted copper pair cannot presently provide for wideband services such as television and has some difficulty with high speed data services although many breakthroughs in this technology are being made daily.

Cable

Cable TV on the other hand is already available in close to 35% of America's homes and passes almost 65% of the homes. Some of the newer cable systems are promising their

subscribers upwards of a hundred channels including two-way capability that would allow home banking, shopping, security services, utility load management, video games as well as the opportunity to work while at home. All of this is offered in addition to the multitude of entertainment and education channels including first run movies and theatre; C-SPAN the channel carrying the proceedings of the Congress; a number of minority networks including the Spanish International Network, the Black Entertainment Network, and the Woman's Channel; new networks focusing on health, finance and sports; several 24-hour news channels; special children's networks; and educational networks such as ACSN's The Learning Channel. Even with all of these channels, cable could have additional unused capacity which might be ideal for distributing local news, high school basketball games, local political debates (and polls), a variety of community meetings and the opportunity to involve citizens in the workings of local city councils.

Cable is also a medium where data services can be supplied directly to home including the downloading of software for computers or providing access to large data bases. Both of these latter functions can also be accommodated over the existing telephone network except that the cable has the capacity to deliver the data much faster.

Fiber Optics

Fiber optics, the hairlike glass strands, are now being installed in many locations in the nation and promise even more communications capability than today's 100-channel cable systems. Although these optical systems are primarily being designed for telephone and data traffic, some communities are selecting fiber for their local cable TV system. The technology of fiber optics, which uses light waves to carry information, is still embryonic. Although the fiber appears to have enormous capacity, it presently has great difficulty carrying television signals. As analog amplifiers or digital compression techniques are developed, this limitation will disappear, and these glass cables will begin to replace copper in most applications. Fiber will do this because it is inherently less expensive (sand is cheaper than copper); its capacity is several orders of magnitude greater than copper cable; and its ease of installation (its small size and flexibility are great advantages in crowded city conduits) will make it the preferred medium for much communications traffic.

Subcarriers

The final distribution technology we will cover concerns subcarriers. Both radio and television signals have subcarriers which are additional signals which can be carried without interfering with the main channel. In television, for

example, the sound is carried on a subcarrier. In radio, the FCC allows additional information to be carried in radio subcarriers called SCA's. For years these radio SCA's have been used to deliver additional radio programs to the blind and as special educational radio channels. Now the FCC has authorized additional subcarriers and has indicated that these channels could be used for data delivery as well as audio. The same holds true for TV. Engineers and entrepreneurs are now working on equipment which will make these technologies affordable and useful. The radio and TV subcarriers will permit paging, data delivery to the home, data exchange between schools, as well as other forms of information distribution. What is exciting about this prospect is the inexpensive nature of the equipment required, and the fact that the channels are broadcast in nature. Like the ether, they are capable of reaching all manner of locations without the expense of cabling and installing dishes.

All of the distribution systems which have been discussed are capable of delivering their information to the home. There are other technologies which are also coming into the home such as teletext and videotext.

Teletext and Videotext

Teletext and videotext are part of a broad group of technologies referred to as electronic publishing. They center on the mass distribution of information using electronic means to deliver and display the printed word.

Although the British began experimenting with videotext almost ten years ago, it has only been in the last few years that this technology has been transformed from futuristic fantasy to everyday reality. Such systems are available today in many locations in the United States, France, Germany, Japan, Canada and Great Britain.

The concept of electronic publishing is fairly simple. Pages of graphics and text are made to appear on the home TV screen. The idea is to give people access to information they now receive from newspapers, magazines and books in a easy-to-use and convenient manner. But the idea of electronic publishing is not a new one. Cable TV systems have used scrolling text for years to provide information to subscribers. But the cable approach has several problems, principally the requirement for a full channel to send such information, and the viewer having no ability to select the information he really wants to see. Scrolling text has had only limited appeal and has been used by cable operators principally as cheap fillers for empty channels.

In theory, the technology to provide a much more useable form of electronic text is inexpensive and sufficiently simple to use so that in time it could become a mass medium. But the design of such systems are fairly complex and require agreement in standards among the many participants in this fledgling industry. It now appears that the standards'

battles are coming to close as broadcasters, carriers and information providers have reached agreements with manufacturers on the precise configurations and features of the equipment involved to allow the new field to move into the home and office.

Teletext uses the broadcast airwaves to deliver a textual channel of information directly to a home TV set equipped with a special decoder. It does so without disturbing or interfering with the broadcast program. The teletext signal itself is encoded digitally and carried in an unused portion of the TV bandwidth called the Vertical Blanking Interval. This interval is the period of time when the electron beam which produces the TV picture moves back to the top of the screen after scanning a complete picture. During this interval no TV picture is sent and a black bar can be seen at the very top of the TV screen when the picture rolls. Sixty times each second that interval occurs providing space for the teletext data to be carried to the home. The data when interpreted by the set top decoder is in the form of pages of information, often as many as 200 in a complete cycle. The TV station which has built and stored the 200 page teletext magazine in its computer transmits each page in numerical order. The viewer selects the page of his choice using a small keypad. This instructs the decoder which data is to be captured from the cycle. The decoder examines each page as it

is received until the correct page number arrives. It stores the data in its memory, looks up the meaning of each-byte of data in a table located in the decoder memory, and uses a built in character generator to reproduce the exact page on the screen. Besides simple alphanumerics, the teletext data also produces detailed graphics in a wide variety of colors. A complete teletext cycle can be transmitted approximately every thirty seconds providing an average waiting time of fifteen seconds. More complex pages require more data to adequately describe their composition, thus reducing the capacity of the system.

Every TV station has the capability to transmit teletext although few are doing so now as little or no decoders are in the public's hands. In the future, TV sets will be sold with teletext decoders built into the chassis at a small increase in price and teletext transmissions will be a common service. One of the advantages of teletext is its ability to be continuously updated at the TV station. Thus late breaking news and events would be available on a moments notice. Early morning school closings could be broadcast continuously as could traffic reports and weather advisories. Teletext is ideal for special announcements and bulletin board information. During periods of registration at colleges, teletext could list classes which have closed providing students with up-to-date information of a rapidly changing

nature. Merchants look forward to teletext for instant sale advertisements and classified ads. Sport's scores and stock market prices also seem ideal for the teletext medium. Because of the technolog^{y's}~~y's~~ limited page capacity however, teletext is not a technology for large bodies of detailed information. It is also not a two-way technology. For these attributes we need a variation of the technology which is called videotext.

Videotext operates in much the same way as teletext in terms of displaying alphanumerics and color graphics on the screen, except that videotext is delivered to the home (or office) over telephone wires or cable. This type of delivery assures two characteristics. One that interaction is possible and secondly that unlimited amounts of information can be accessed. In a videotext system a computer stores a very large number of preformatted pages (essentially a data base of pages), which a user accesses by sending a signal from his terminal to the computer and requesting a specific page. The computer responds by sending that particular page to the subscriber. Since each user is connected to the computer through a separate set of telephone wires, such a system can handle multiple requests simultaneously.

Some of today's videotext data bases provide access to over one hundred thousand pages of text and graphics. Using a small keyboard, the user can access the videotext data base

and extract information on virtually any subject. The data bases have been designed to be fully interactive, and have the capability to respond to specific questions. Videotext is not simply a computerized collection of information. It can, for example, handle not only a list of items in a commercial catalog, but also take orders for products in the catalog. It provides not only the names and menus of local restaurants, but can make reservations as well. It can show airline schedules and make reservations. It might not only show lists of classes which are open during school registrations, but would also add the student's name to the open class. Videotext is a fully interactive, user friendly, highly graphic and color capable computer data base which goes beyond any previous attempts to encourage public access to the world of powerful data bases.

Many of information providers and system operators of these electronic text systems now recognize that the micro-computers which have silently moved into many homes provide an excellent starting place for text delivery systems. Thus software is increasingly becoming available to allow home computers to be used as videotext terminals. One such system from Avcor, costing only \$100.00, allows the Commodore 64 to be used with the most advanced videotext system, NAPLPS (The North American Presentation Level Protocol.) Other software packages are available which can work with Apples, TRS-80's,

and IBM pc's.

Home Computers

Home computers have evolved in the last few years from providers of video games into machines that rival yesterday's mainframe computers. Even though millions have been sold to families, their acceptance on a consumer level is still far from complete. For those who have computers, they are still, as one reviewer has described, like Dorothy's ruby slippers in the Wizard of Oz. Dorothy never suspected the power her slippers really had, and home computer users are likewise not in touch with the true abilities of their machines. That I predict, will take some time to happen.

The computer in the home environment is quite simply a management tool that when used with the appropriate software has the potential of taking over some tedious household tasks. Before we get into those tasks, let me mention several recent and noteworthy advances in the field. Within the last year several new products were introduced including touch sensitive screens, windows, programmable keys, and the mouse. Each of these products is intended to simplify the computer's operation in the hands of inexperienced users, especially the novice or first-time user. But interacting with a computer is still not like having a conversation with HAL, the computer aboard the space ship in 2001. HAL not only understood verbal commands, but also had a mind of his own. Several

speech recognition systems are presently available but their cost is in the thousand dollar range and their capability limited. Other systems now on the drawing boards of engineering companies will dramatically lower this cost while making a dramatic leap in conversing with your computer. Artificial intelligence or knowledge-based systems are also in their infancy.

A major problem area with computer acceptance is having computers perform functions which are of real value in the home environment. Real value functions might include home security such as protection from intrusion and fire; utility management including automatic control of heating and air conditioning; keeping track of information such as mailing lists, calendars, phone numbers and even recipes; providing for home banking and shopping; and of course, assisting in the education of children and adults.

In the office environment, several applications programs for the professional user have appeared which represent major advances since the introduction of word processing programs. Lotus 123 was introduced last year combining spreadsheet analysis with graphics and data base management and is today's best selling program. Another advance is represented by the problem solver programs such as TKISolver, Thor, Microsoft's Project and ThinkTank.

On the home front, a wide variety of educational programs are available including at least six SAT preparation programs, as well as study programs for the GRE and ACT. One of the SAT programs by Krell Software, guarantees users a 70 point increase in their scores or a refund of the purchase price. A large number of LOGO programs for young users can be purchased paving the way for their introduction to computers. Logo as you recall is the simple but powerful computer system developed by Seymour Papert at MIT that has been used very successfully to teach young children about programming. Recently, several volumes of PLATO, the well known computer assisted instruction software originally intended for large CDC computers, have been redesigned by Control Data and are now available for microcomputers. These include programs on math, physics, French, German, and computer literacy. The recent introduction of the Bank Street Speller to assist the Bank Street Writer, provides word processing and spelling for home computers well within the grasp of young operators as well as their computer tentative parents. The list of new and exciting educational and instructional software is endless.

A good question at this point might be, where are all of these developments headed? Trying to predict the future for home computers is somewhat akin to climbing a greased pole. If you do in fact get to the top, its very easy and quick to find yourself at the bottom again. Most of the

hardware and software being developed at laboratories around the world is done in the utmost secrecy. Trying to get into the third floor at Apple Research is tougher than getting in to the national security briefing room.

In my view of the future I have to deemphasize the importance of learning how to program. It simply is not productive for those of us who want to use computers in the home environment to spend countless hours figuring out how to program the wiley machines. That's being done by very highly paid professionals. What we do need is computer competence. We need to be able to sit in front of a computer and interact with it on a one-to-one basis. We must become proficient in using this tool. As for the tool itself what can we expect? Actually it's not very hard to imagine the computer future. Hardwarewise less expensive machines that eventually can be afforded by every family. I believe that machines with the power and simplicity of Apple's MacIntosh will be available in the \$200-\$300 range. Speaking of Apple's MacIntosh, this is also part of the future. Computers that hold your hand and help you get the information you want such as the Mac will be in plentiful supply, as will be portables of all kinds that can be taken to the beach or on a plane. Computability is also in the future. Driving a car has gotten to be a very simple process. No matter where in the world you are, cars all work the same way. So do telephones. That same future is

possible for computers.

The real advances will come in computer controlled accessories. In order for the computer to make breakfast for us it will need to interface with a breakfast machine. For the computer to see that the grass is trimmed it will need to interface with a landscaping device, perhaps a robot. For the computer to do things around the home and take the tedium out of housework it needs connections to instruments which do housework. Already several computer controlled products are available from a company called BSR which control lights and appliances as well as air-conditioning and heating systems. These devices along with software control will provide a reason for the computer's presence in the home other than as an information machine.

Videodiscs

A number of years ago I began to work in a serious way with optical videodiscs. These storage devices have the capability to hold 54,000 separate images on a single side of a 12" disk. Although originally designed to hold high quality video pictures, the videodisc is actually an immense digital storage medium. All of the information contained on the disk is in the form of binary data, i.e., zeros and ones, embeded in the form of microscopic pits on the disk's surface. In a typical 12" disk there may be as many as 14 billion of these minute indentations arranged in 54,000 circular tracks. A beam

of light focused down to $1/30,000$ th of an inch strikes the disk and is reflected back to a photo detector except where the light strikes one of these indentations. This on-off light beam is translated into electrical signals which contain all of the information necessary to form a television picture. When played back over a TV set these 54,000 pictures can provide 30 minutes of continuous television. This is however the least imaginative way of using the optical videodisk. Each of the 54,000 circular tracks is equivalent to a single TV picture making it possible to have as many as 54,000 individual frames on one side of the optical videodisc. When the player is programmed to play the same circular track over and over again, a still frame results. However since there is no physical contact with the disk, no needle, just a low-powered light beam bouncing off the surface, the disk can be held in still-frame mode for as long as necessary without any harm to the disk. The 1000th play is just as clear and bright as the 1st play. The optical reader can also be made to move one frame at a time either forward or reverse resulting in slow motion. Finally, each frame of the disk is encoded with a reference number, similiar to a page number. This allows the device its most outstanding feature...the ability to search out and retrieve instantaneously any frame at any time.

While optical videodiscs are primarily used today to sell movies for the home market, their promise to provide new

forms of programs is far more exciting than their present use. For example, entire series of books could be published on discs and viewed on a screen in the still-frame mode. With 54,000 separate frames available, the Encyclopedia Britannica would fit on one side of a disk. Using both sides of the disk one could store the Library of Great Books, complete with all pictures. A disk was recently published called the Mystery Disk which when used in conjunction with the disk player's control unit, allows the viewer to participate in the mystery by selecting one of a number of offered scenarios as a starting point. Based in that selection, different events occur each time the disk is played. The viewer can stop the disk at any time and asks for clues and information. All of this activity gives the viewer the opportunity to determine who committed the crime. Each time the disk is played a different character may be the criminal

The Library of Congress has the largest collection of stored knowledge in the world. A significant number of its eighty million items are in an advanced state of deterioration. To help preserve documents the Library is in the process of transferring many of these documents to optical videodiscs. Once transferred, they could be made available to scholars, schools or the home.

Since the disk is capable of freeze frame and slow motion, it is ideal for various kinds of instruction. Golf

and tennis swings can be seen in slow motion and duplicated until perfect. Cooking disks allow the viewer the optimum opportunity to replicate complicated dishes. Exercise disks lead the viewer through aerobics at their own pace.

Last year a version of the Sears catalog was produced on videodisc and sent to selected homes. The American Heart Association has produced a videodisc on CPR which is linked to a sensor equipped mannequin and can tell the student if chest pressure is incorrect and then demonstrate the correct procedure.

One of the most exciting prospects for the videodisc is its potential role in education. For years our children have been exposed to instructional television. Yet no matter how sophisticated the programming, the economics of TV production are such that programs are designed for the mass audience and not for the individual. Computer assisted instruction on the other hand has been available since the mid-1960's but has yet to be considered a resounding success. Whether educational designers can do much more than use the computer for simple testing routines without significant advances in sophisticated graphics and new techniques remains to be seen. However if we marry the computer and the Videodisc we may have a very powerful instructional tool. The computer can be linked directly to a videodisc program and can guide a student through various lessons and testing, and then

move to remedial work or on to more advanced concepts as his ability indicates. Instructional experts now agree that the videodisc and computer form an ideal instructional system which could have broad implications for education.

One final example use of videodiscs which I think you will find exciting. The ability of videodiscs to search out and retrieve any frame has led to what has been called vicarious travel. By connecting two disc players to a small microcomputer, engineers have designed a system which allows the viewer to manipulate large amounts of video information on a real-time basis. One such disc was created by mounting several cameras on the back of a small truck, and driving through Aspen, Colorado. Pictures were taken one a second of every street and each was encoded with a special number identifying its location in the city, as well as its relationship to the other pictures being taken. All of the photos were transferred to two videodiscs, and their code numbers were fed into a computer. This "movie map" as we call it was then connected to a device which controlled both the disk and the computer through a "joystick" mechanism, a special device which acted as a steering wheel and a gas pedal. With a single frame of the disk displayed on the TV screen, you begin to travel by moving the joystick forward. This starts you moving down a street in Aspen. At every corner you have a choice...turn or go straight. Based on your

decision, the computer responds immediately by displaying on the screen the path you would have been traveling on had you really been in Aspen. When you wish to stop and look around, you do that by merely stopping the movement of the joystick.

Maps have been made of New York, Paris, London and the National Gallery of Art. Imagine walking down the aisle at the Louvre and stopping at any work of art, all stored perfectly on the disk. The 1983 his and her's gift in the Neiman Marcus catalog offered a similar system attached to an exercise bicycle. The bike was positioned directly in front of a projection TV. As the exerciser begins pedaling, the scenery on the screen changes accordingly. The screen responds to the bikers every movement including stopping and turning. As hills appear, the computer causes additional resistance to be added to the bike and so pedaling becomes more difficult. Likewise pedaling downhill is easier. The ultimate in travel without ever leaving your living room. Disks in the future will allow you to visit the more exotic places on earth without the travel time, danger or expense normally involved.

Video Cassettes

The most surprising development in the media field in 1983 was the amazing growth in sales of home video cassette recorders. As of the beginning of this year 10% of American homes (approximately 8 million) had VCRs---a number large

enough to interest the owners of programs and advertisers. Interesting enough, the growth of VCR sales parallels very closely the early years of color TV.

The Supreme Court's decision in January of this year upholding the legality of taping copyrighted programs off the air removes a significant impediment to the medium's growth. Virtually all video cassette recorders are made overseas, principally in Japan, although a flood of cheaper Korean made machines are due by the end of this year. Since some VCRs were already selling for around \$300 in 1983, this new competition could bring prices down to the \$200 level and below. The potential market for machines at these prices is enormous. The movies which are becoming available for the videocassette market are more and more of first-run vintage. Producers are finding the recorded cassette market extremely profitable. Paramount's Raiders of the Lost Ark delivered more than half-a-million copies of the cassette and 100,000 video discs of the same title. With twenty percent of the wholesale price going to the copyright holder, Paramount has already realized a sizeable income from the movie in cassette and disc rights alone.

VCRs offer the consumer the ability to time shift TV programs, rent first run movies and classics, or to make ones own movies with a low cost camera. Of the programs which are available for rental some are instructional in nature and many

are educational including the National Geographic specials and the Shakespeare plays. Now the home library of books can be supplemented with the video cassette library.

The future for VCRs promises smaller and less expensive recorders and tapes, 8mm is the latest format, and less expensive accessories, especially cameras and editing machines. One of the byproducts of these consumer video machines is interest being shown by young people in producing home TV programs. At the recent National History Day competition in Washington D.C., no less than six groups entered programs which they had produced themselves with home video equipment. It is clear that more and more young people are becoming interested in video production with access to low cost, easy-to-use equipment.

High Definition Television

Most of the new technologies discussed thus far depend on the home television set as a final display device. Although many viewers receive what they consider to be high quality TV pictures, there appears to be a demand for much higher quality television spurred on by large screen television makers, and those seeking to compete with theatre quality images. This new system is called High Definition Television (HDTV) and several competing designs are presently being developed. The two biggest changes between today's TV and high definition are the number of lines used to form a

complete picture, and the aspect ratio of the image. Today's North American standard defines TV as composed of 525 individual lines. In addition, screen size is 4:3 width to height. Engineers working on high definition standards are moving in the direction of 1125 lines per picture, and a 5:3 aspect ratio. Designers believe that this resolution will provide quality equivalent to 35mm photography, and that viewers prefer wide screens similar to feature films. Our eyes can resolve about one minute of arc; this corresponds to 1750 lines at a distance of twice the screen height. But additional lines per picture demand additional bandwidth during transmission. A 1750 line system would require excessive spectrum, not to mention its incompatibility with current technology. The compromise appears to be in the neighborhood of the 1125 line system being proposed by the Japanese broadcasting agency.

The experimental HDTV images are impressive, far superior to traditional television; there is about five times the information. The equipment to perform HDTV is costly and will require some breakthroughs in recording and camera technology before they are perfected. But beyond these problems the biggest impediment is to find a place in the spectrum for this high bandwidth signal. Present calculations indicate that we would have to give up 5 UHF channels for one HDTV channel, and this seems impossible. The only

over-the-air remaining spectrum may be in the DBS band where several companies including CBS have suggested HDTV be carried. We can look forward to high definition television by 1990 but at a cost few of us may be willing to part with.

Smart Cards

Many of the advances which we discussed today are a result of the dramatic developments in a field which we call microelectronics. The most obvious result is the computer on a chip as it has been called. By using manufacturing techniques that were impossible only a few years ago, scientists have been able to construct solid state devices which while they may contain over 100,000 elements, are too small to be seen except under a microscope. Many unrelated industries are now becoming beneficiaries of these developments. One is the banking and credit card industry. A card has now been developed which on the surface does not appear any different from the credit cards you are now carrying. Yet imbedded between the plastic layers of this card is a small computer on a chip. This so-called 'smart card' is the credit card, checkbook, and traveler's cheque of the future. It is your ticket to the opera and the football game. Such a card is being tested today in a number of cities. A user makes ordinary purchases with the card. When the card is inserted into a merchant's machine, purchases can be recorded on the card, and balances deducted from the cards' account.

Like writing a check. When the owner returns home, the card has a record of the purchases which can be printed out or stored. Some cards will go to the bank to get recharged when their balances run out. Others will allow the owner to make loans like overdraft checking. Some will allow traveler's cheques to be validated for trips. The same principles used in making smart cards are being used by the Army to make "electronic dog tags" - which contain all of a serviceman's vital records.

Unlike today's bank and credit cards, these plastic devices have built-in intelligence. More advanced models will be able to provide positive identification of the user through digitally compressed signatures, fingerprints, voice prints or eye prints. These physiologically linked identifiers will prevent unauthorized use of the card.

This technology represents another move towards the cashless checkless society where we are rapidly moving, for better or for worse.

Conclusion

One of the implications which I foresee of this information and communications revolution is the end of the metropolis. When it is possible to work from the home, be educated through television, have access to the world's great libraries and museums, then the need for the big cities and their pollution is gone. When you can talk face to face with

any person on earth and cycle through the pyramids of Egypt without ever leaving your living room, why live in a crowded city.

What is of greatest concern to me is making sure that the developments I have discussed are beneficial to the human race and not simply technology for technology's sake.

I'm reminded of the evening Kraft Ericke came to dinner at my home. At the time he was Chief Scientist of the Apollo project, having been one of Von Braun's rocket scientists at Penne Munde during the war. Kraft was describing a robot which he had designed and which could accomplish some Herculean tasks. My wife interrupted to ask why he couldn't design a robot to do housework. He responded that there were more important things to be done than that. "I know" said my wife, "that's why I'd like a robot to do housework"!